Appendix B – Ecological Systems Conservation Elements

Organization of Appendix B

The following sources and results are provided for each Ecological System (vegetation community) conservation element: a Conceptual Model, a description of the analytical process (including source data) and/or a Process Model for each management question, and results in the form of maps and other supporting graphics. Access to a data portal to examine the results in greater detail is available at the BLM website http://www.blm.gov/wo/st/en/prog/more/climatechange.html.

Ecological Systems Conceptual Models

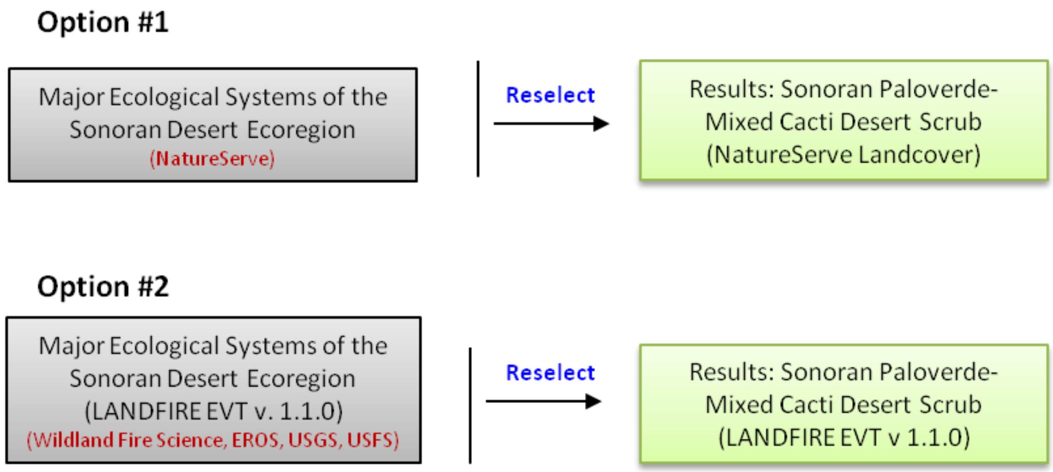
Conceptual models used in the Sonoran Desert REA organize and articulate the relationship between the various change agents and natural drivers for a particular conservation element. Not all of the relationships identified lend themselves well to measurement or monitoring but they are still important to include as it aides in our general understanding of complex interactions.

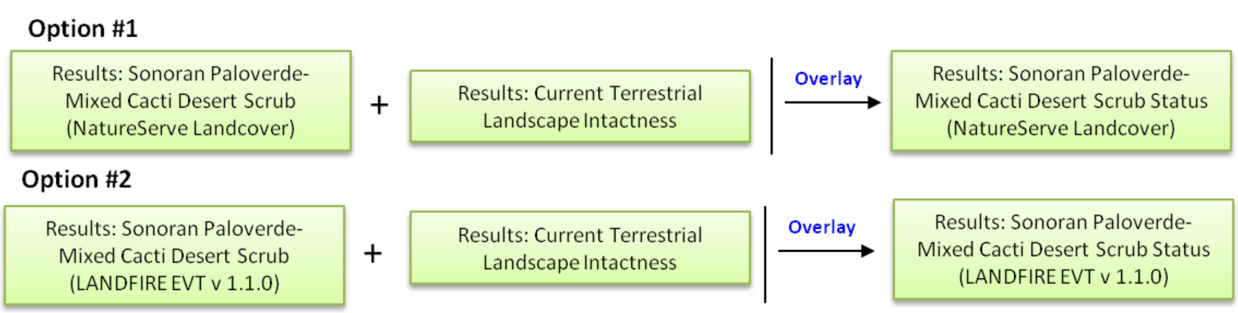
All ecological systems conceptual models include a series of change agents (depicted with yellow boxes) and natural drivers (cyan boxes). Specifics regarding some of the factors are presented in blue text. Within each ecological system, one or more dominant species are included in the model. Arrows represent relationships between the various change agents and natural drivers with the community overall and, where appropriate, with the dominant species more directly. More specific information is provided by the orange text. Thicknesses of the arrows **DO NOT** represent degree of importance. Rather, bold lines represent those factors that are tracked or modeled to varying degrees of certainty throughout the REA analysis.

Fire regime is influenced by a complex interaction of factors: fuel load and condition, grazing, invasive species, and fire frequency (both natural—a function of climate—and human-caused—a function of development). Fire suppression is another influencing factor on the fire regime. Climate change and development affects the entire complex and all of its components. Natural ecological systems are shaped by a natural fire regime and altered by a different regime. Native ecosystems can also be directly affected by invasive species and grazing. No natural system is fixed in time or space, and it is the individual species that respond to environmental change rather than the community.

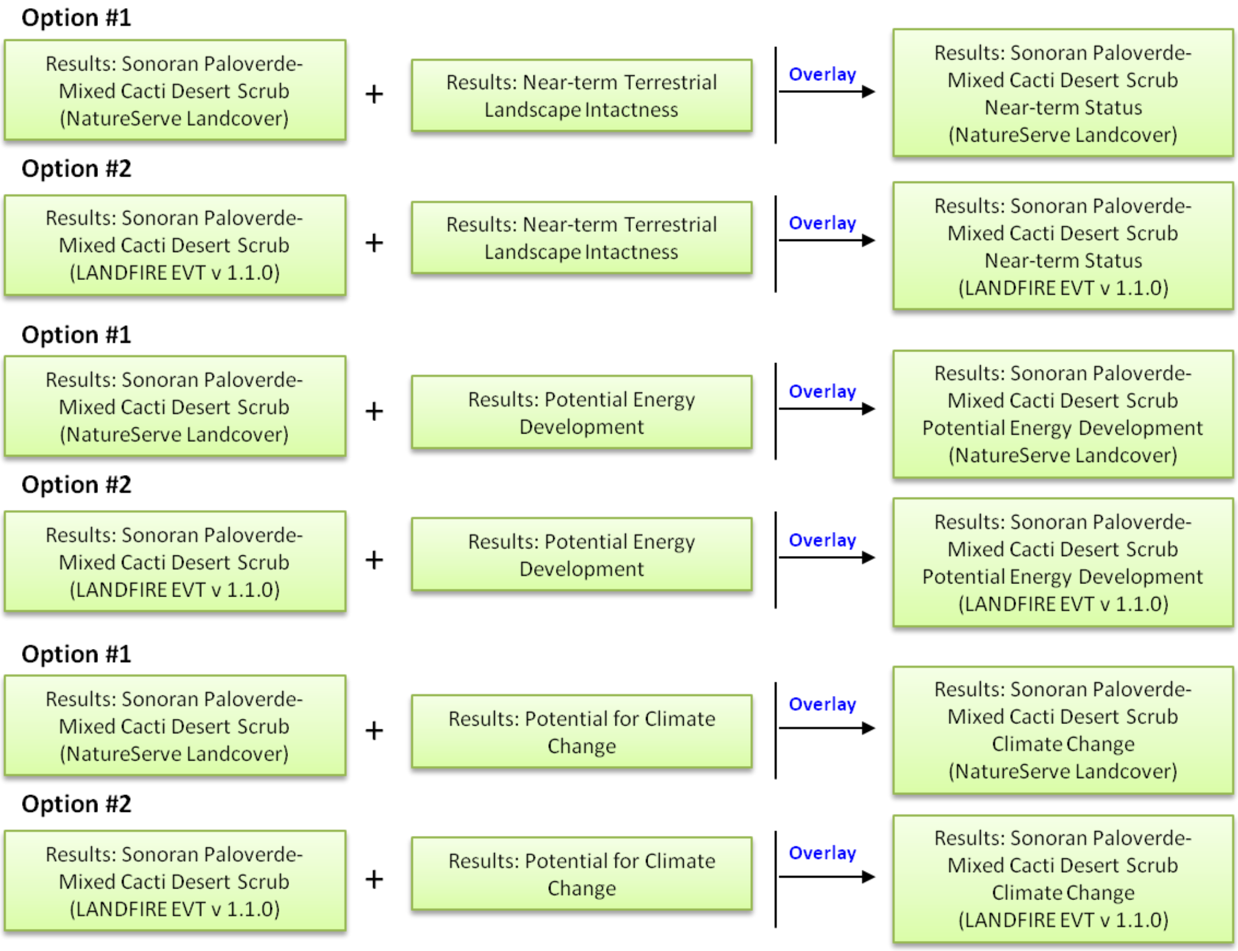
Process Models

MQ C1. Where are existing vegetation communities of interest present and what is their current status?

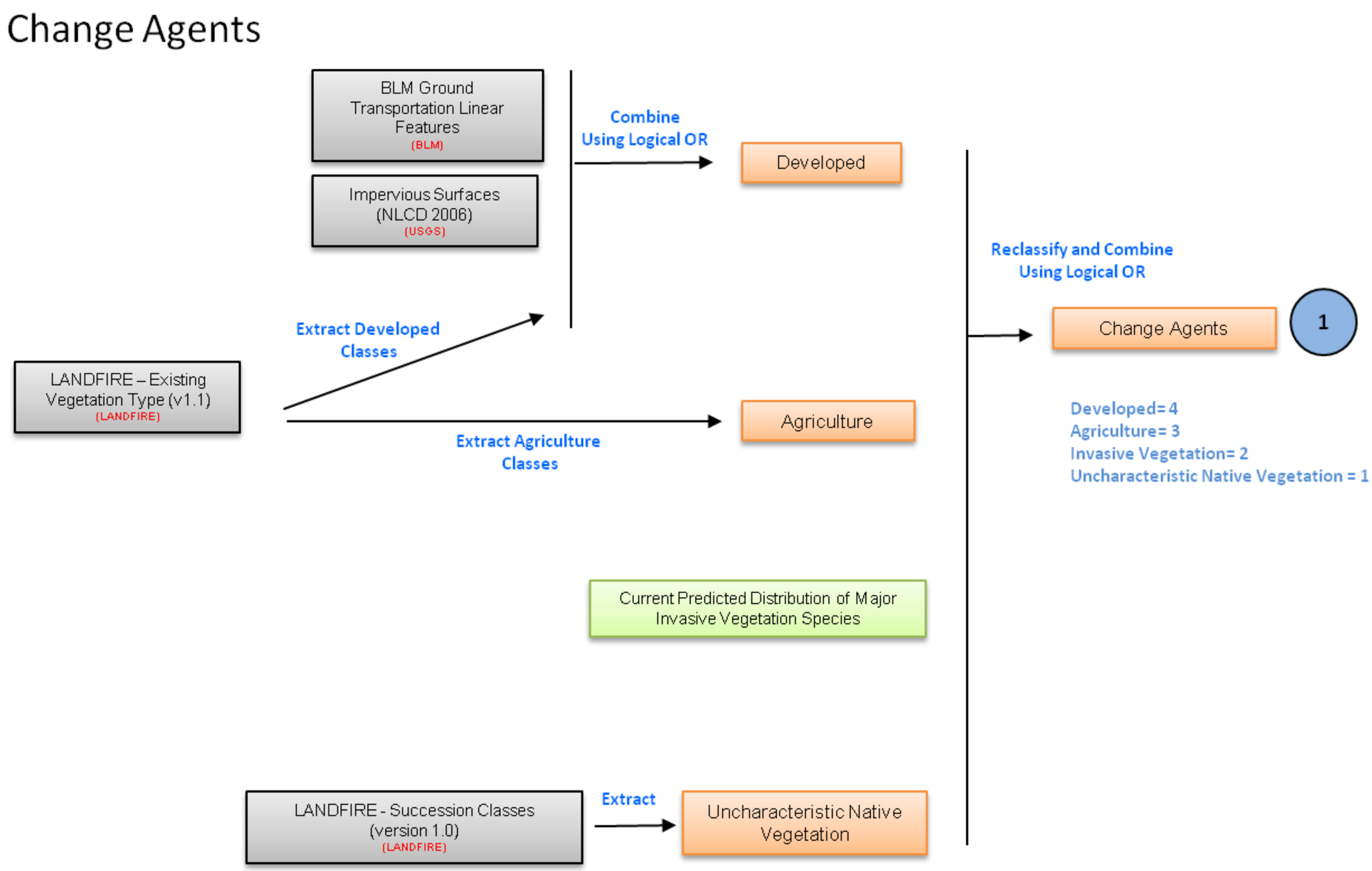




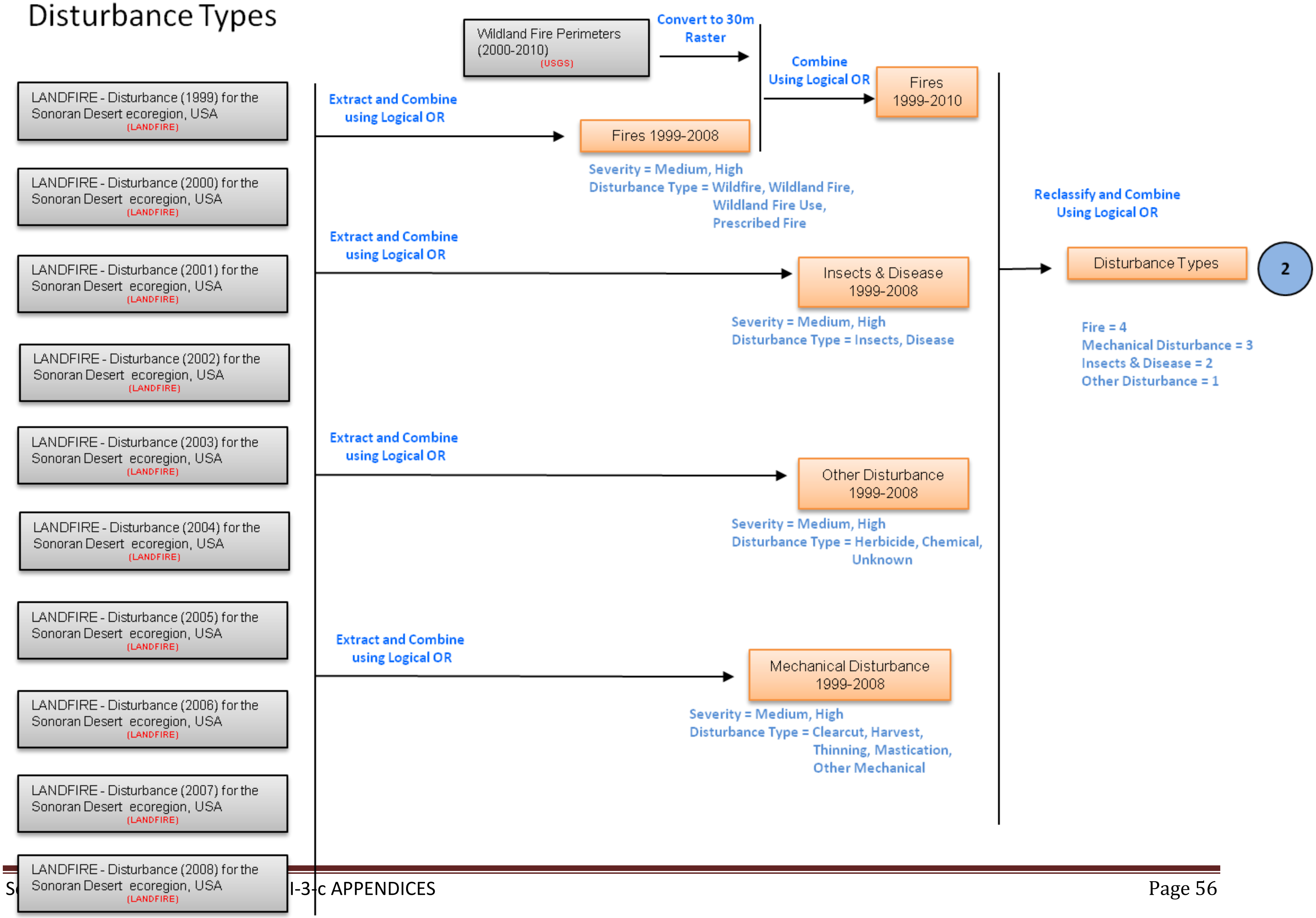
MQ C2. Where are vegetative communities likeliest to be vulnerable to change agents in the future?

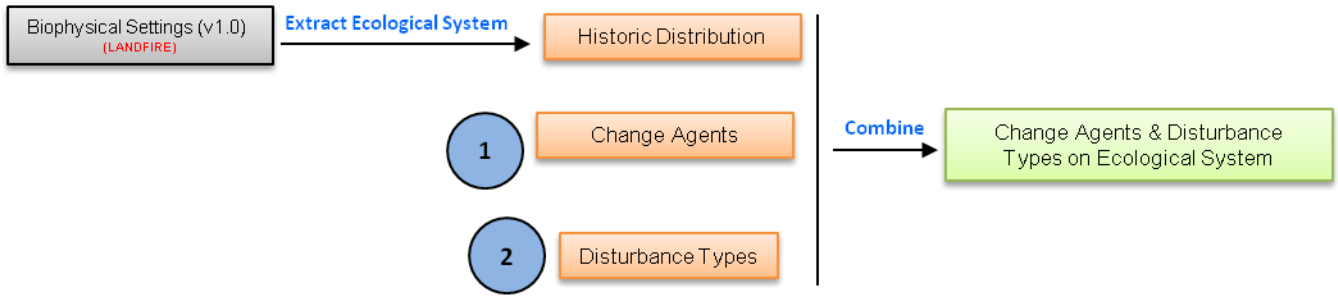


MQC3. What change agents have affected existing vegetative communities?



Disturbance Types




Biophysical Settings (v1.0)
(LANDFIRE)
Extract Ecological System
Historic Distribution
1
Change Agents
2
Disturbance Types
Combine
Change Agents & Disturbance Types on Ecological System

Conceptual Model

There are six primary natural drivers (cyan boxes) for this ecological system including topography, erosion, soil characteristics, precipitation, temperature, windthrow, and animal herbivory. Specific details on the various environmental conditions characterizing this system (blue text) are provided by NatureServe (2009) and LANDFIRE (2007).

Sonoran Paloverde-Mixed Cacti Desert Scrub is a matrix community of the Sonoran Desert comprised of a few to many different plant species controlled by soil moisture and local geomorphic conditions (Brown 1982). This ecological system is characterized by the dominant overstory plant, saguaro cactus (*Carnegiea gigantia*), but other canopy species are present. Bursage (*Ambrosia deltoidea*) is the dominant understory species and often serve as a nurse plant for the dominant overstory plants (McAuliffe 1988). Extended periods of drought and extreme cold events limit this ecological system.

Historically, fire was not part of the natural disturbance regime and native plant species have not evolved fire-adapted strategies. With the influx of non-native invasive grasses as the result of disturbance (including widespread livestock grazing), more frequent fire has become more commonplace across the landscape. Windthrow is a significant mortality source for saguaro as is illegal removal of the species for ornamental planting.

Change agents affecting this ecological system accounted for in the REA process include Development (based on current and projected future extent of urban land cover) and recent disturbance (1999–2008) from Mechanical Removal, Fires, and Insects and Disease. Overall landscape intactness, which includes development from all sources (urban, agriculture, energy, and roads), invasive species, and habitat fragmentation, is used to describe the regional environment that contains this ecosystem type. Climate change projections (including precipitation and temperature changes as well as MAPSS modeling outputs are also used to predict where the current Sonoran Paloverde-Mixed Cacti Desert Scrub may be under significant climate stress.

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Brown, D.E. (ed.). 1982. Biotic communities of the American Southwest. *United States and Mexico Desert Plants* 4(1-4):1–342.

LANDFIRE Biophysical Setting Model. September 2007.

McAuliffe, J.R. 1988. Markovian dynamics of simple and complex desert plant communities. *American Naturalist* 131:459–490.

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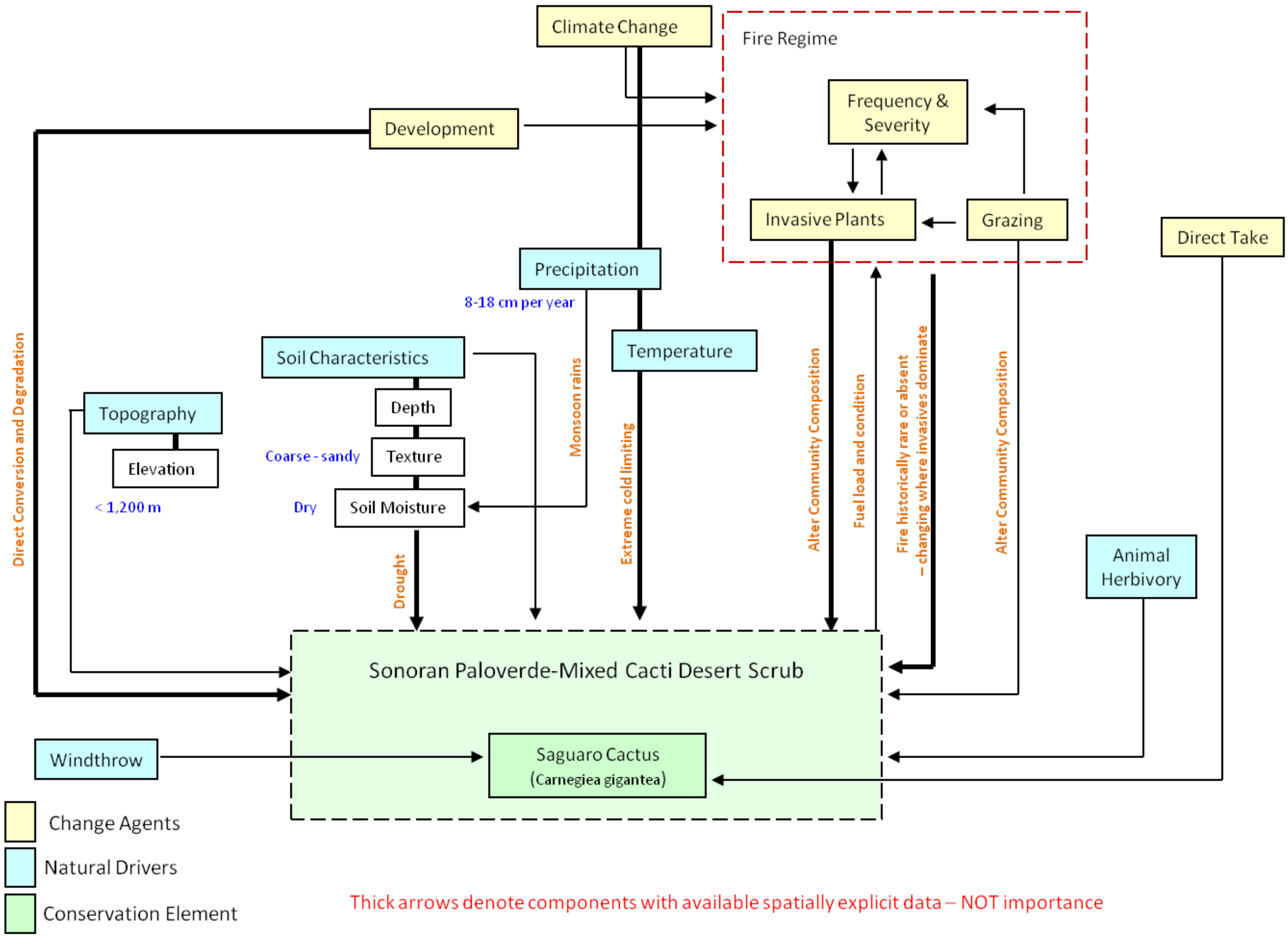
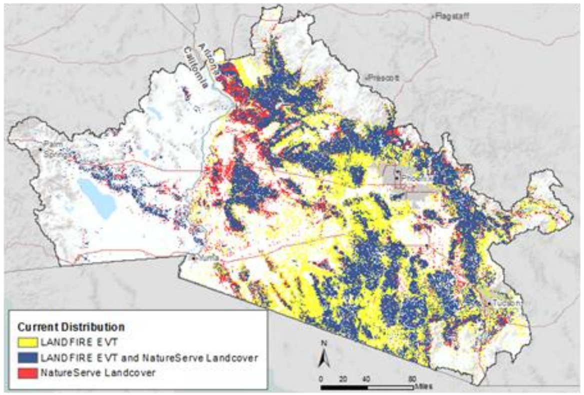


Climate Change
Fire Regime
Frequency & Severity
Development
Invasive Plants
Grazing
Direct Take
Precipitation
8-18 cm per year
Temperature
Soil Characteristics
Depth
Texture
Coarse - sandy
Soil Moisture
Dry
Topography
Elevation
< 1,200 m
Monsoon rains
Extreme cold limiting
Drought
Direct Conversion and Degradation
Alter Community Composition
Fuel load and condition
Fire historically rare or absent – changing where invasives dominate
Alter Community Composition
Animal Herbivory
Sonoran Paloverde-Mixed Cacti Desert Scrub
Windthrow
Saguaro Cactus (Carnegiea gigantea)
Change Agents
Natural Drivers
Conservation Element
Thick arrows denote components with available spatially explicit data – NOT importance

Results

MQ C1. Where is existing Sonoran Paloverde-Mixed Cacti Desert Scrub and what is its status?

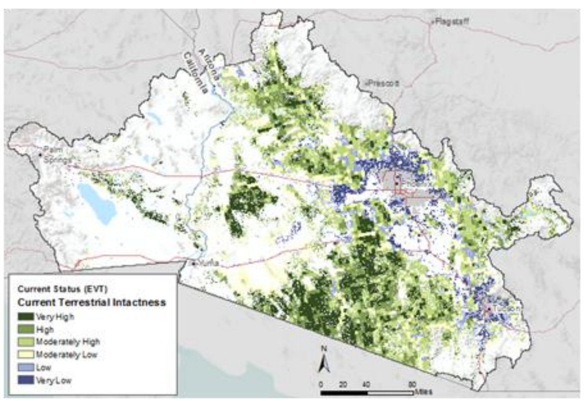


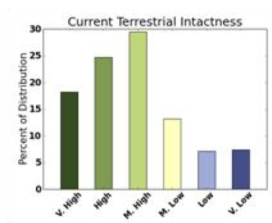
Distribution of Sonoran Paloverde-Mixed Cacti Desert Scrub LANDFIRE (yellow), NatureServe (red), and both (blue).

Vegetation Community	LANDFIRE Only (ac)	NatureServe Only (ac)	Both (ac)	Percent Overlap
Sonoran Paloverde-Mixed Cacti Desert Scrub	5,332,340	1,796,793	7,373,363	50.84

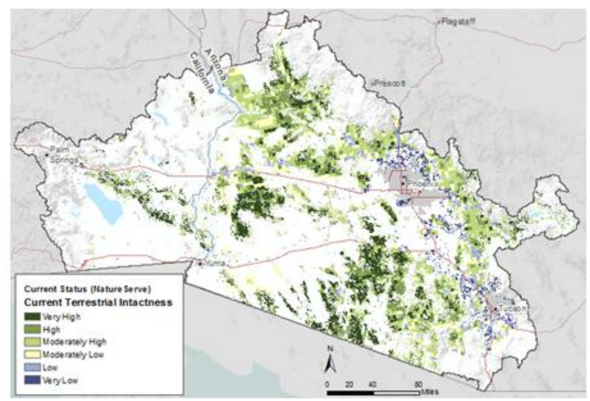
Status

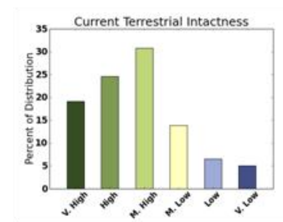
LANDFIRE





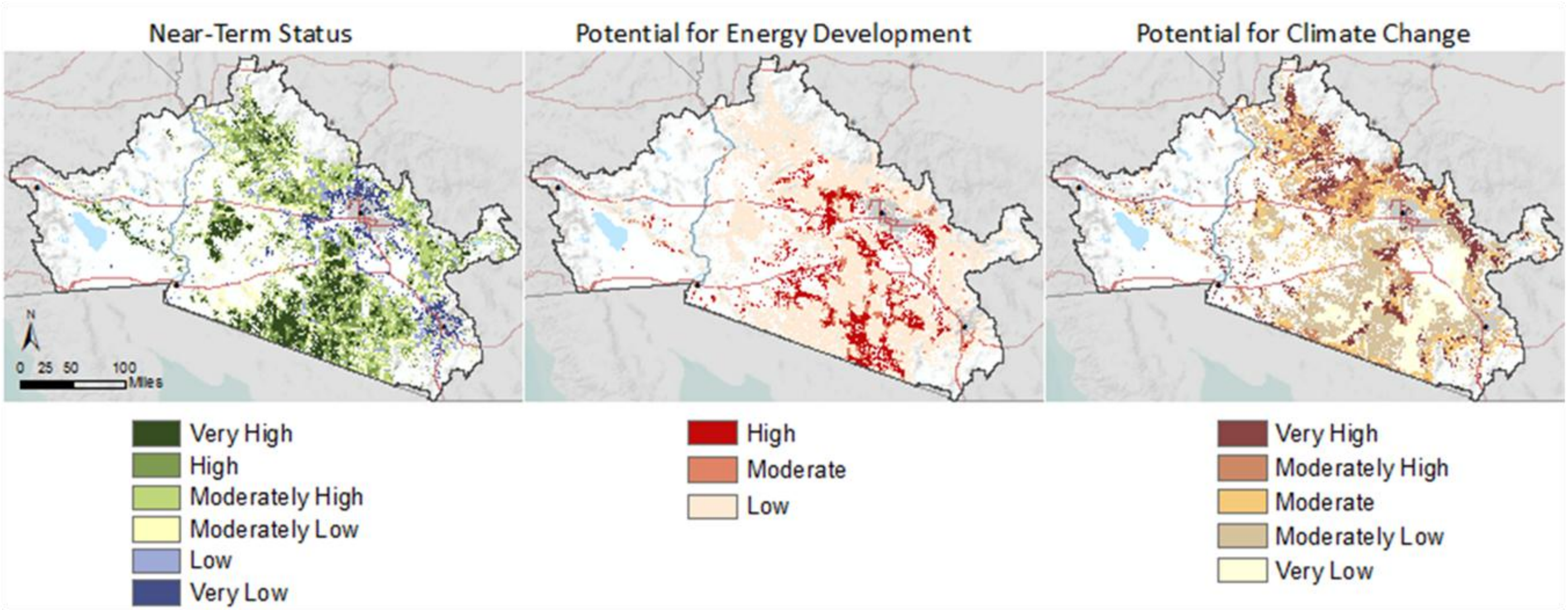
NatureServe

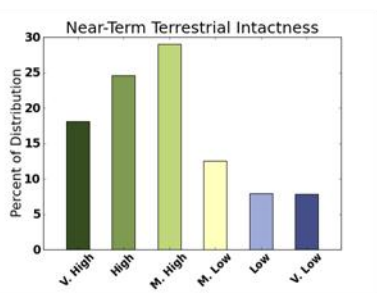


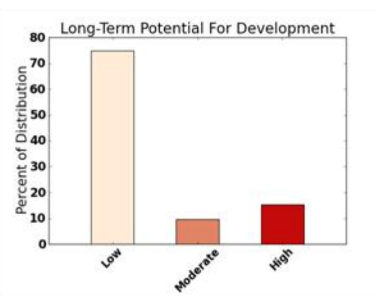


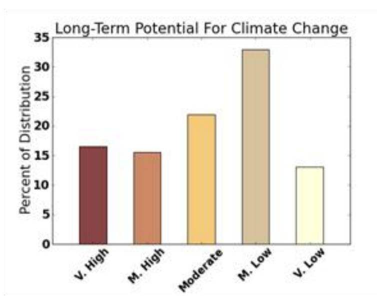
MQ C2. Where is Sonoran Paloverde-Mixed Cacti Desert Scrub vulnerable to change agents in the future?

LANDFIRE



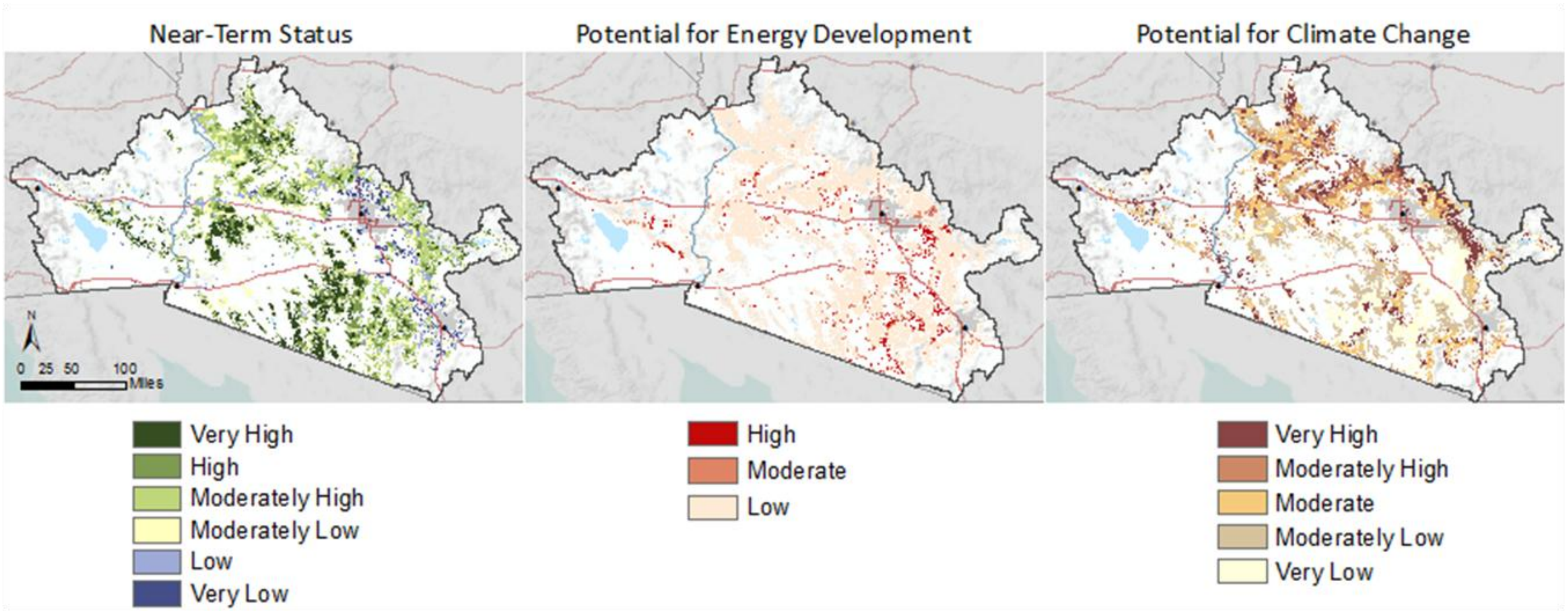


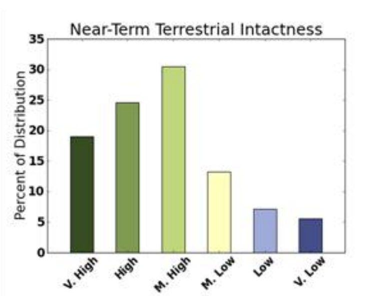


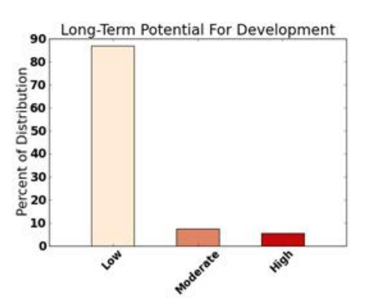


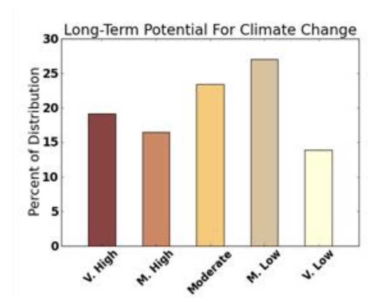
MQ C2. Where is Sonoran Paloverde-Mixed Cacti Desert Scrub vulnerable to change agents in the future?

NatureServe

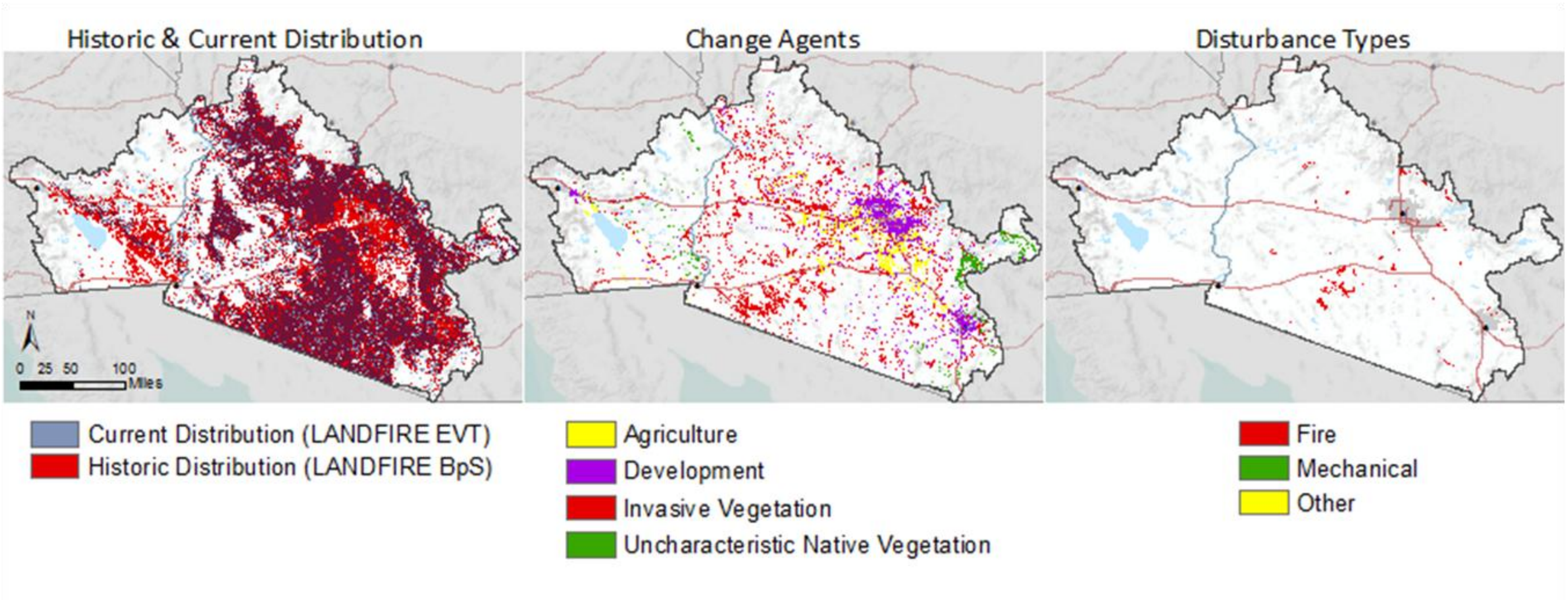








MQC3. What change agents have affected Sonoran Paloverde-Mixed Cacti Desert Scrub?



Historic Change Agents (change from modeled reference condition [LANDFIRE BpS dataset]

Total BpS Area	Urban & Roads	Agriculture	Invasives	Unchar Native Veg	Total Changed	Percent
15,730,037	1,255,201	672,008	2,345,345	429,066	4,701,620	29.89%

Recent Disturbance (1999–2008)

Total BpS Area	Fire	Mechanical	Other	Total Disturbed	Percent
15,730,037	212,197	0	18	212,215	1.35%

Conceptual Model

There are five primary natural drivers (cyan boxes) for this ecological system including topography, erosion, soil characteristics, precipitation, temperature, and animal herbivory. Specific details on the various environmental conditions characterizing this system (blue text) are provided by NatureServe (2009) and LANDFIRE (2007).

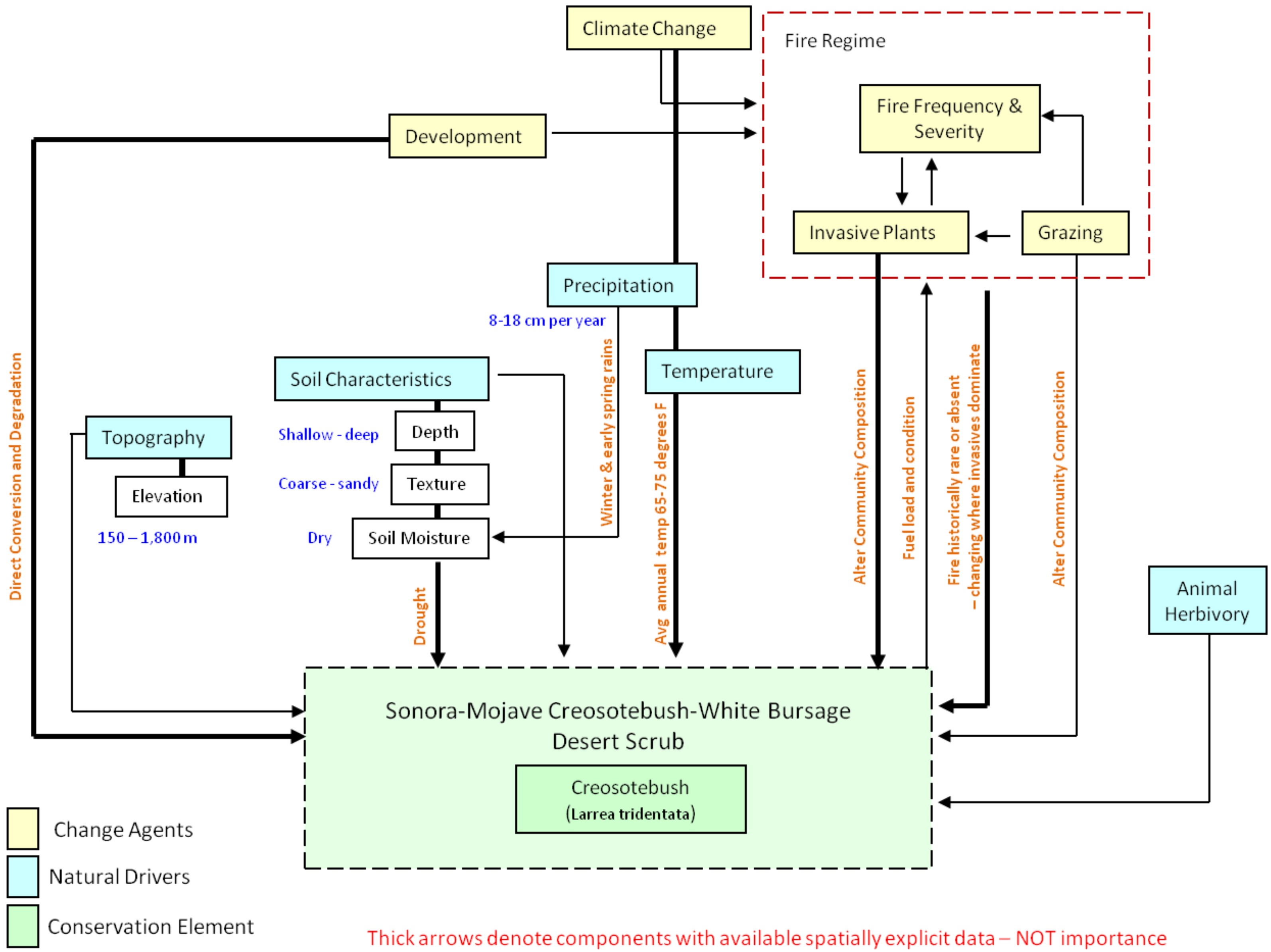
Sonoran-Mojave Creosotebush-White Bursage Desert Scrub is a matrix community dominated by the very long-lived creosotebush (*Larrea tridentata*). Other constituents of the community are determined by local soil moisture and landform. Livestock grazing has had a major impact on the ecosystem and invasive grasses dominate in some areas altering the fire regime completely. Historically, this ecological system rarely if ever burned. Species like creosotebush are intolerant of fire and the system recovers very slowly after a burn.

Change agents affecting this ecological system accounted for in the REA process include Development (based on current and projected future extent of urban land cover). Overall landscape intactness, which includes development from all sources (urban, agriculture, energy, and roads), invasive species, and habitat fragmentation, is used to describe the regional environment that contains this ecosystem type. Climate change projections (including precipitation and temperature changes as well as MAPSS modeling outputs are also used to predict where the current Sonoran-Mojave Creosotebush-White Bursage Desert Scrub may be under significant climate stress.

References

LANDFIRE Biophysical Setting Model. September 2007.

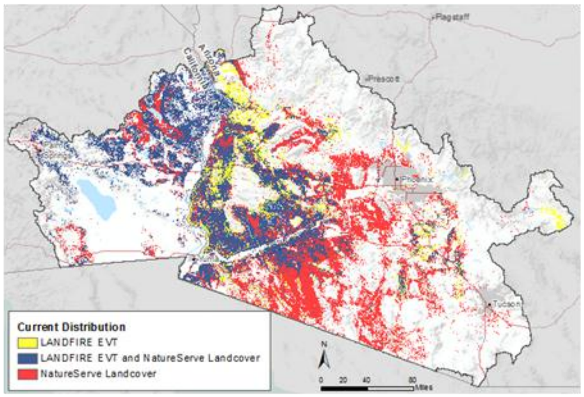
NatureServe. 2009. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Database. Arlington, VA.



Climate Change
Fire Regime
Fire Frequency & Severity
Development
Invasive Plants
Grazing
Precipitation
8-18 cm per year
Soil Characteristics
Temperature
Topography
Depth
Shallow - deep
Texture
Coarse - sandy
Elevation
Soil Moisture
Dry
150 – 1,800 m
Direct Conversion and Degradation
Winter & early spring rains
Avg annual temp 65-75 degrees F
Alter Community Composition
Fuel load and condition
Fire historically rare or absent – changing where invasives dominate
Alter Community Composition
Drought
Animal Herbivory
Sonora-Mojave Creosotebush-White Bursage Desert Scrub
Creosotebush (Larrea tridentata)
Change Agents
Natural Drivers
Conservation Element
Thick arrows denote components with available spatially explicit data – NOT importance

Results

MQ C1. Where is existing Sonoran-Mojave Creosotebush-White Bursage Desert Scrub and what is its status?

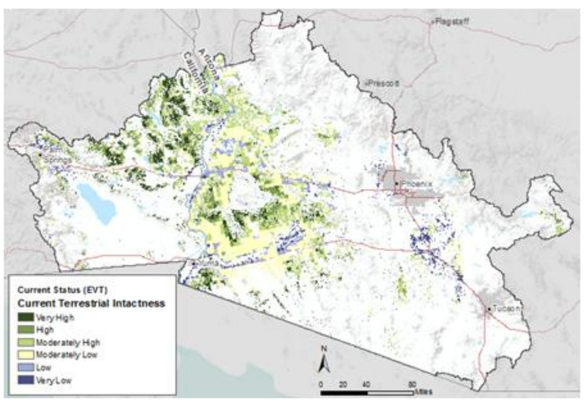


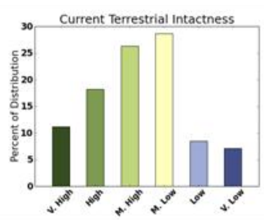
Distribution of Sonoran-Mojave Creosotebush-White Bursage Desert Scrub LANDFIRE (yellow), NatureServe (red), and both (blue).

Vegetation Community	LANDFIRE Only (ac)	NatureServe Only (ac)	Both (ac)	Percent Overlap
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	5,361,364	1,417,474	4,823,357	41.6

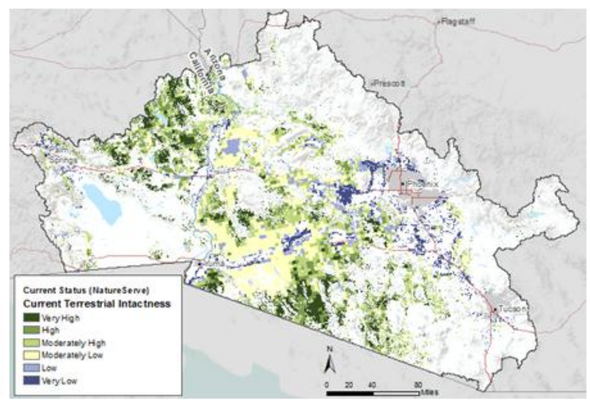
Status

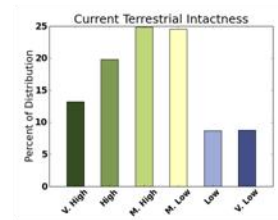
LANDFIRE





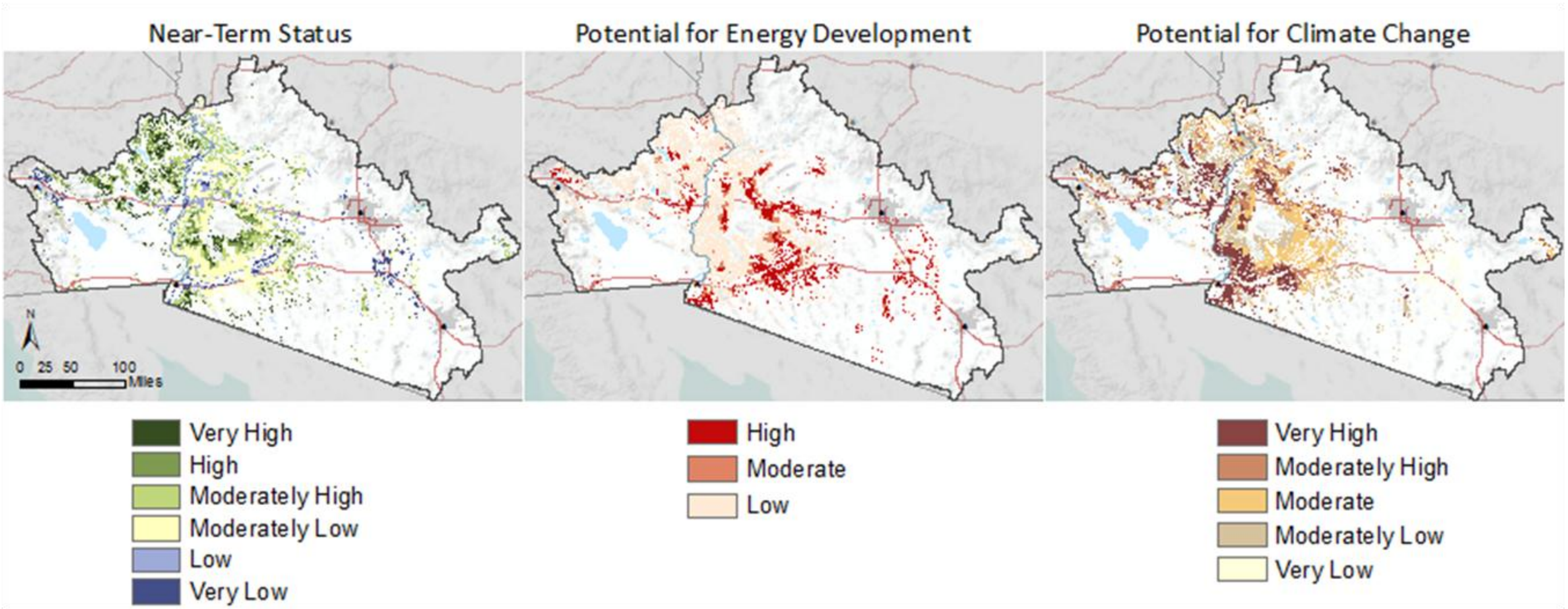
NatureServe

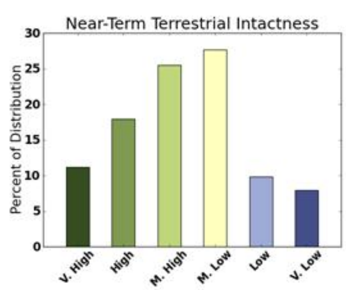


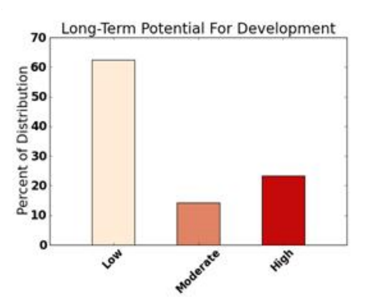


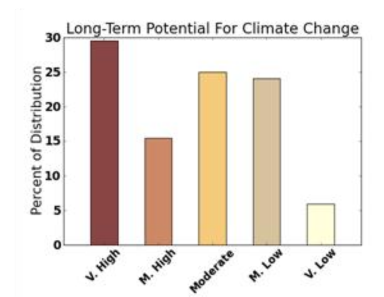
MQ C2. Where is Sonoran-Mojave Creosotebush-White Bursage Desert Scrub vulnerable to change agents in the future?

LANDFIRE



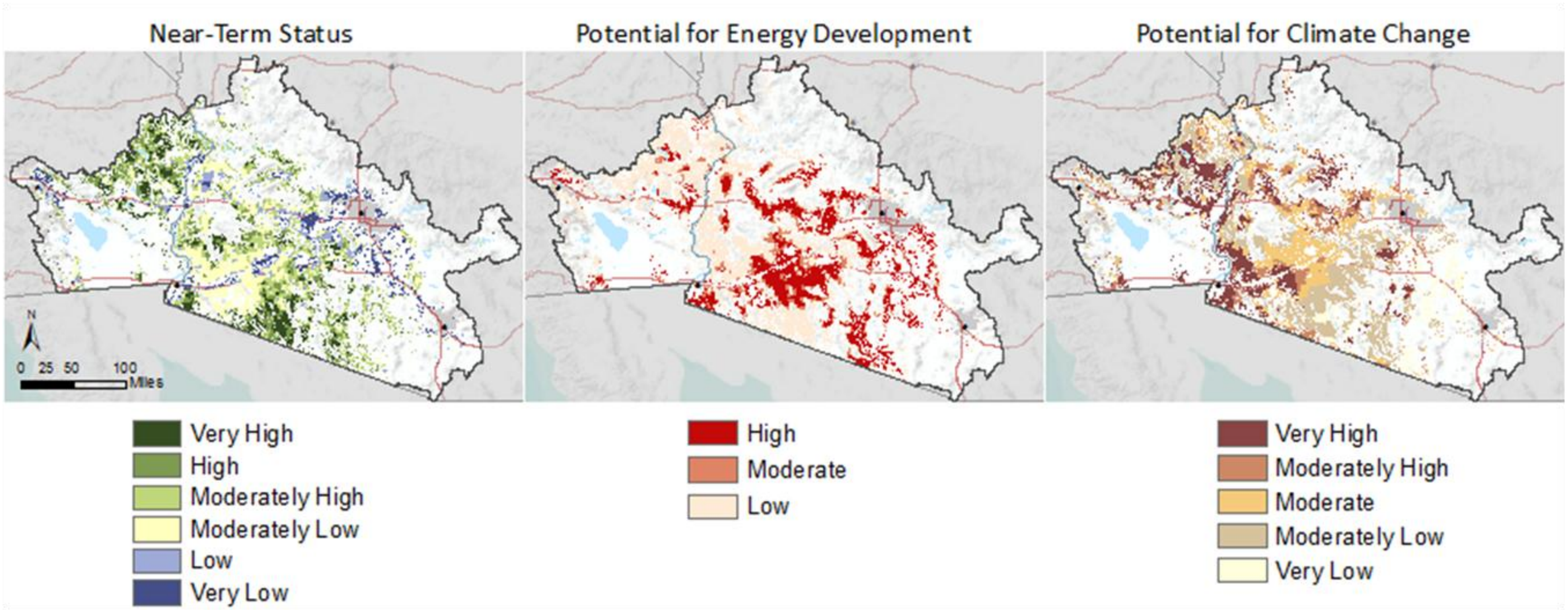


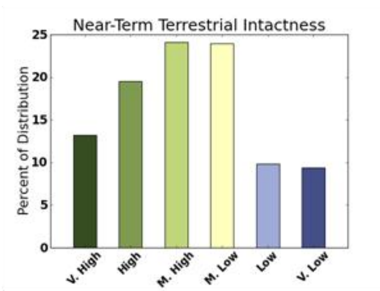


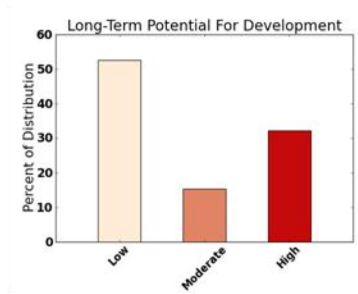


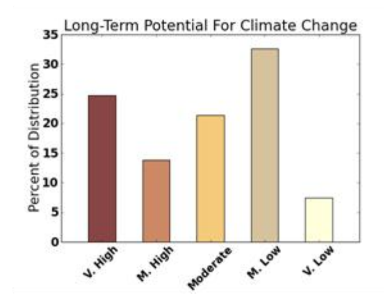
MQ C2. Where is Sonoran-Mojave Creosotebush-White Bursage Desert Scrub vulnerable to change agents in the future?

NatureServe

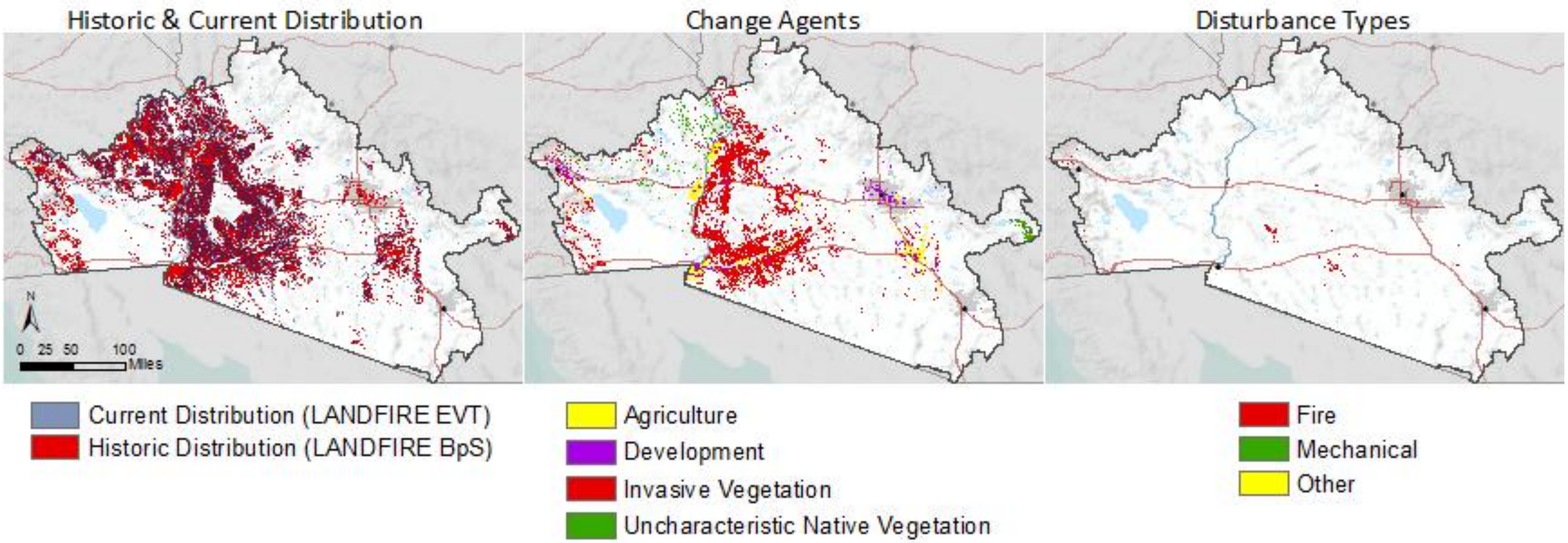








MQC3. What change agents have affected Sonoran-Mojave Creosotebush-White Bursage Desert Scrub?



Historic Change Agents (change from modeled reference condition [LANDFIRE BpS dataset]

Total BpS Area	Urban & Roads	Agriculture	Invasives	Unchar Native Veg	Total Changed	Percent
7,857,699	429,263	432,831	2,909,387	273,834	4,045,315	51.48%

Recent Disturbance (1999–2008)

Total BpS Area	Fire	Mechanical	Other	Total Disturbed	Percent
7,857,699	85,434	0	80	85,514	1.09%

Riparian Vegetation

Conceptual Model

Riparian ecological systems have undergone significant physical and biological changes throughout the ecoregion due to numerous factors, including: conversion to other uses; changes in the natural flow regimes and suppression of fluvial processes (Stromberg 2001, Stromberg et al. 2007); livestock grazing (Armour et al. 1994); and invasive species dominance, such as tamarisk (Horton 1977, Friedman et al. 2005, Merritt and Poff 2010).

There are six primary natural drivers highlighted in the conceptual diagram: groundwater, channel geomorphology and soils, precipitation, temperature, stream hydrology, and animal herbivory. Together these shape the composition, structure, and function of riparian ecosystems.

The yellow boxes in the diagram, which denote the major change agents, impact these drivers in a number of ways. Some development directly converts riparian vegetation to other land uses, especially irrigated agricultural lands in this arid or semi-arid region. Development also affects riparian ecosystems in other ways including drawdown of groundwater lowering the water table, water use and contamination of surface water, and diversion from dams and various water management practices.

The climate regime (precipitation and temperature) regulates the water quantity and delivery to the system. In this ecoregion, moisture tends to be seasonal and flashy, and any significant departure from this pattern can degrade riparian ecosystems.

Fire regime is influenced by a complex interaction of factors—fuel load and condition, grazing, invasive species, and fire frequency (natural, a function of climate, and human-caused, a function of development). In the case of riparian vegetation, the fuel load and condition of surrounding vegetation is as much or more of a factor than the condition of the riparian vegetation itself, which is obviously wetter than surrounding conditions. Fire suppression is another influencing factor on the fire regime. Riparian vegetation is affected by fire in two ways. There is the outright burning of the vegetation and, more broadly, there are changes in water retention and runoff over the larger burn area outside the riparian zone resulting in alterations in the amount of water and sediment that reaches the riparian zone.

Livestock grazing has damaged approximately 80% of stream and riparian ecosystems in the western US (Belsky et al. 1999). Grazing alters streamside morphology, increases sedimentation, degrades riparian vegetation through trampling and consumption and causes nutrient loading to the system. Invasive plants such as tamarisk often successfully out-compete native species such as willows, because of its reproductive capacity and its tolerance to drought and flooding events (Stevens and Waring 1985, Glenn et al. 1998, Stromberg et al. 2007).

Mapping riparian systems is difficult to do using satellite remote sensing. The narrow linear nature of the community makes it difficult to delineate with high levels of accuracy. The most recent landcover edited by NatureServe was used for the REA assessment to assess current distribution. There was ample data for development, fire, tamarisk, and dams and diversions to assess current and future condition and to address the management questions related to this topic. An aquatic intactness model was also developed to describe the upland impacts to aquatic environments more accurately: the aquatic intactness model can be overlaid against the existing riparian habitat data throughout the ecoregion.

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Armour, C., Duff, D. and Elmore, W. 1994. The effects of livestock grazing on western riparian and stream ecosystems. Fisheries 19(9): 9–12.

Belsky, A.J., A. Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. *Journal of Soil and Water Conservation* 54:419–431.

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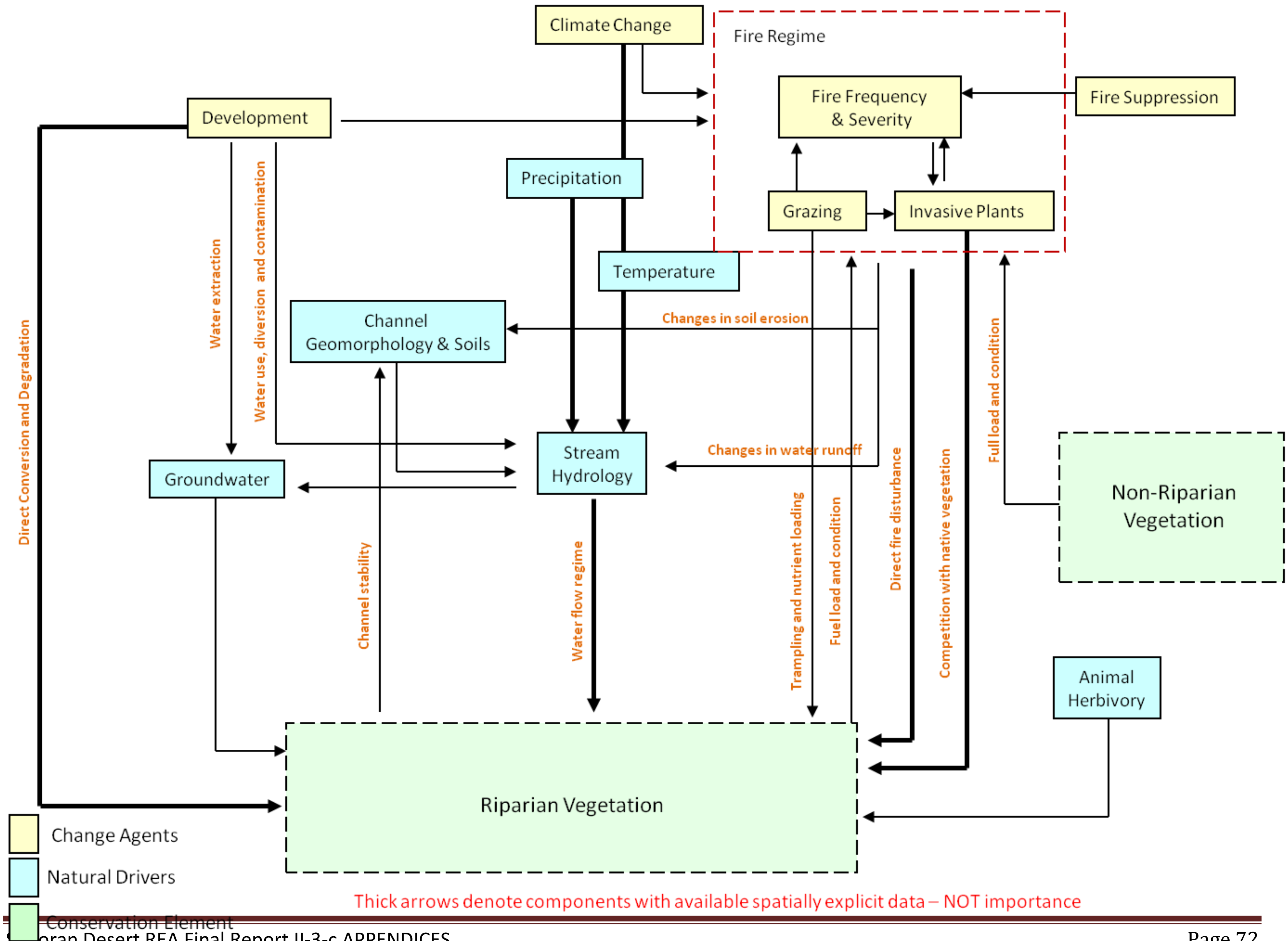
Stevens, L.E., and G.W. Waring. 1985. The effects of prolonged flooding on the riparian plant community in Grand Canyon. Pages 81–86 *in* Johnson, R.R., C.D. Ziebell, D.R. Patten, P.F. Ffolliot, and R.H. Hamre (eds.), Riparian ecosystems and their management: Reconciling conflicting uses. General Technical Report RM-120. U.S. Forest Service, Tucson, Arizona. 523 pp.



Thick arrows denote components with available spatially explicit data – NOT importance

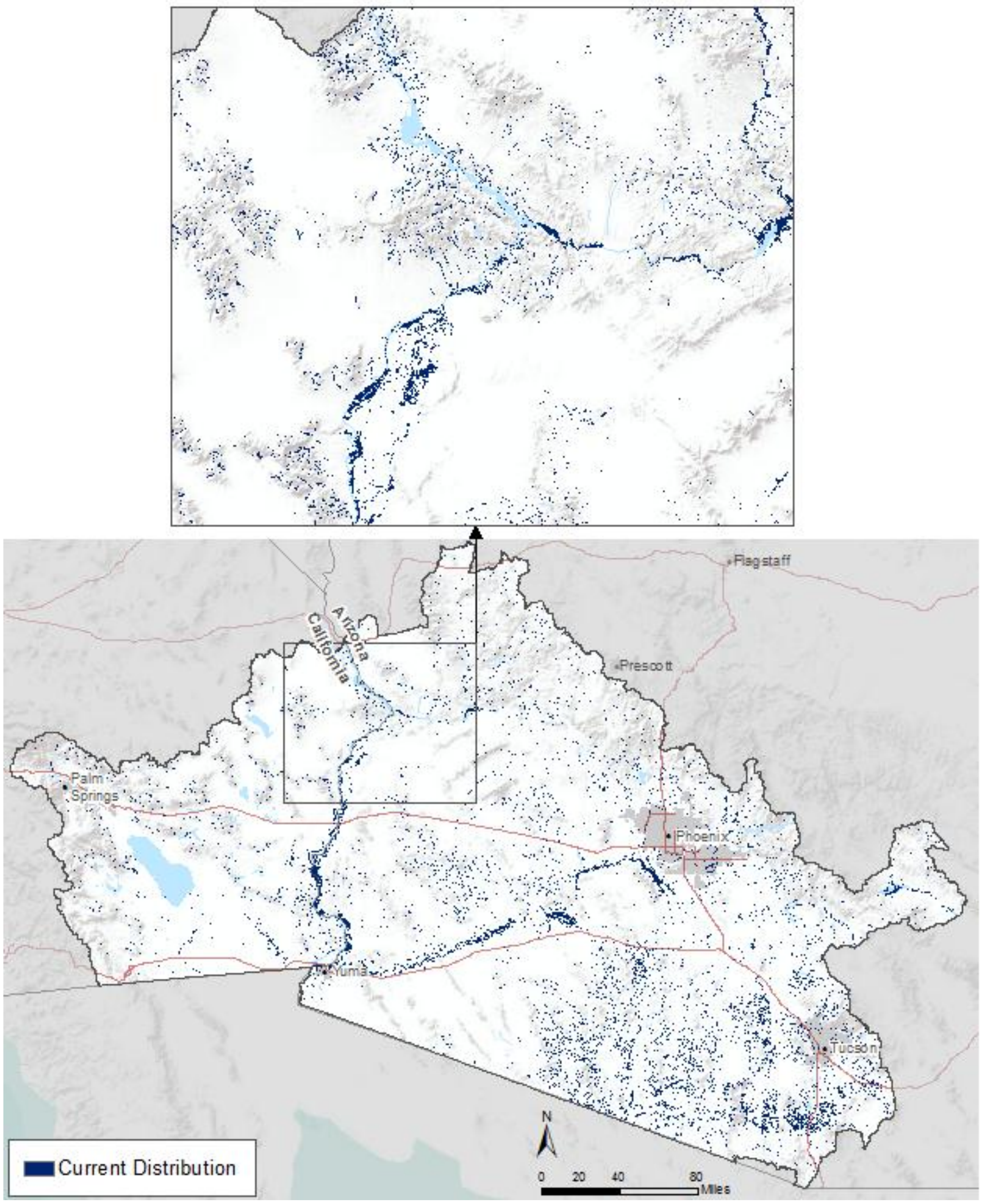
Results

MQ C1. Where is existing Riparian Vegetation and what is its status?

Access to a data portal to examine the results in greater detail is available at the BLM website: http://www.blm.gov/wo/st/en/prog/more/climatechange.html.

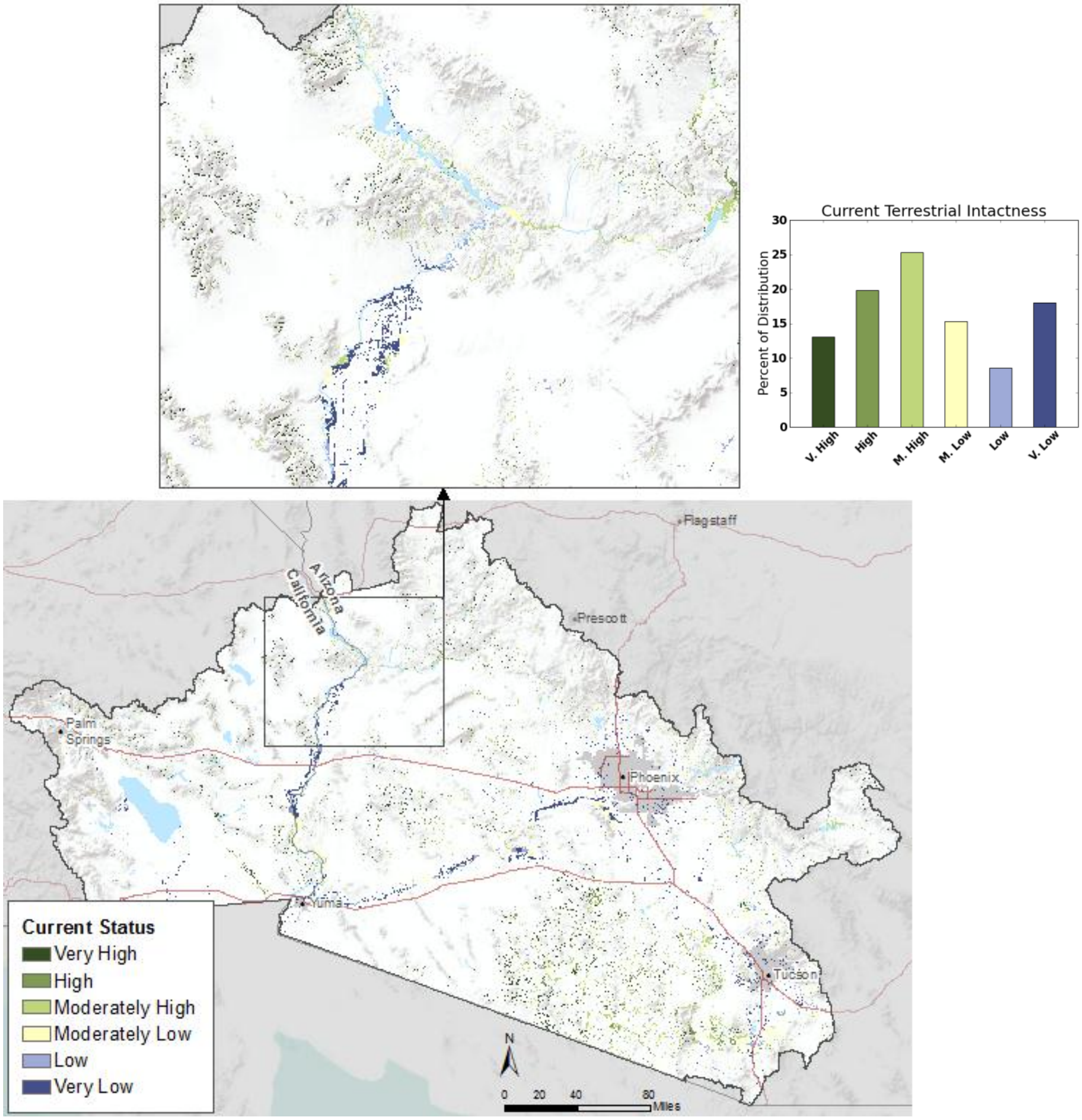
NatureServe data only

Distribution



MQ C1. Where is existing Riparian Vegetation and what is its status?

Status



MQ C2. Where is Riparian Vegetation likeliest to be vulnerable to change agents in the future?

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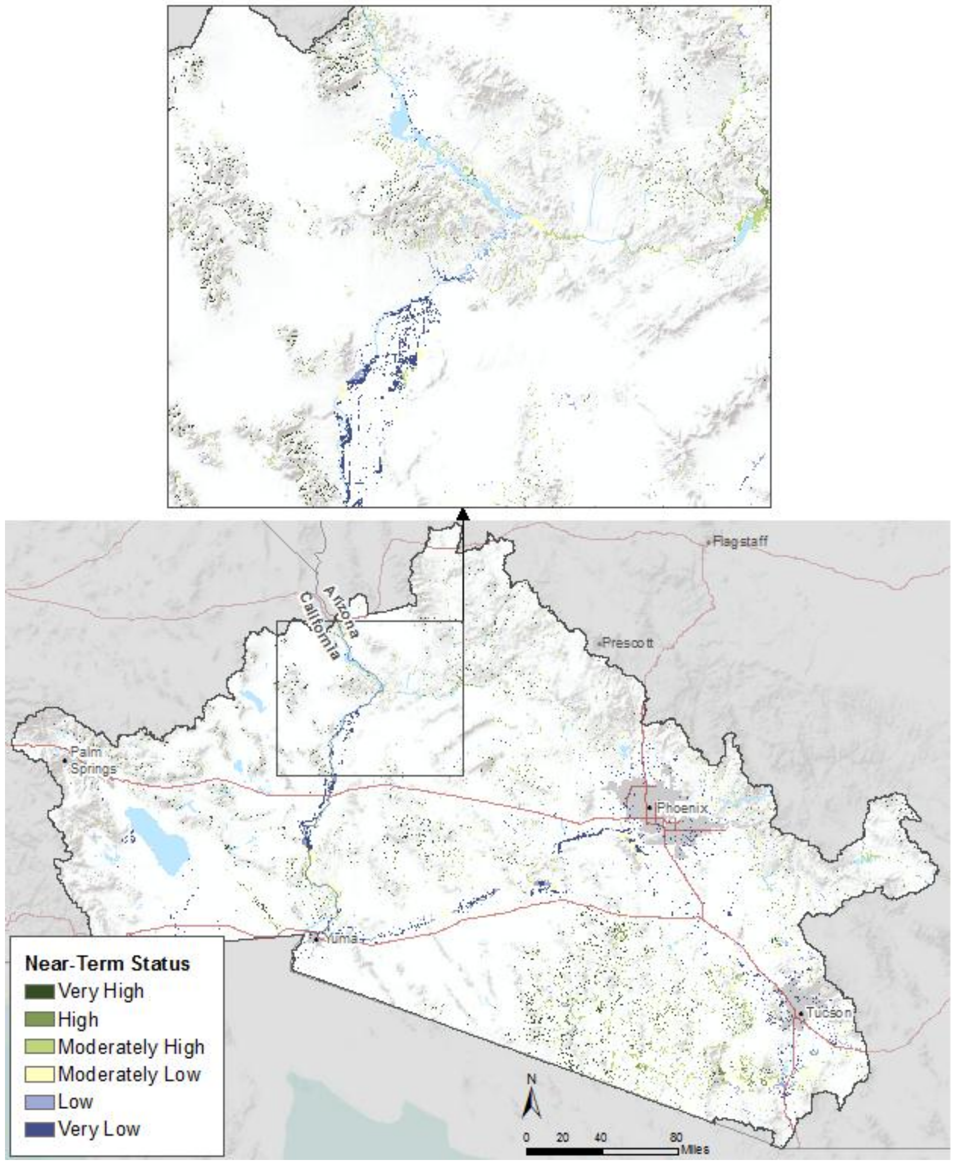
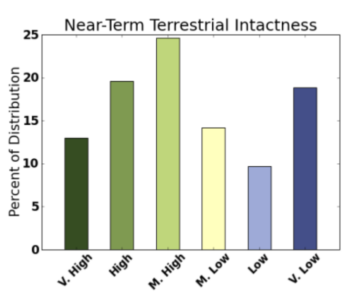
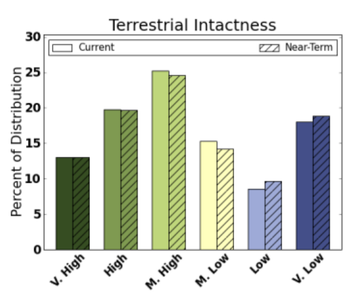
Near-term Future Terrestrial Intactness



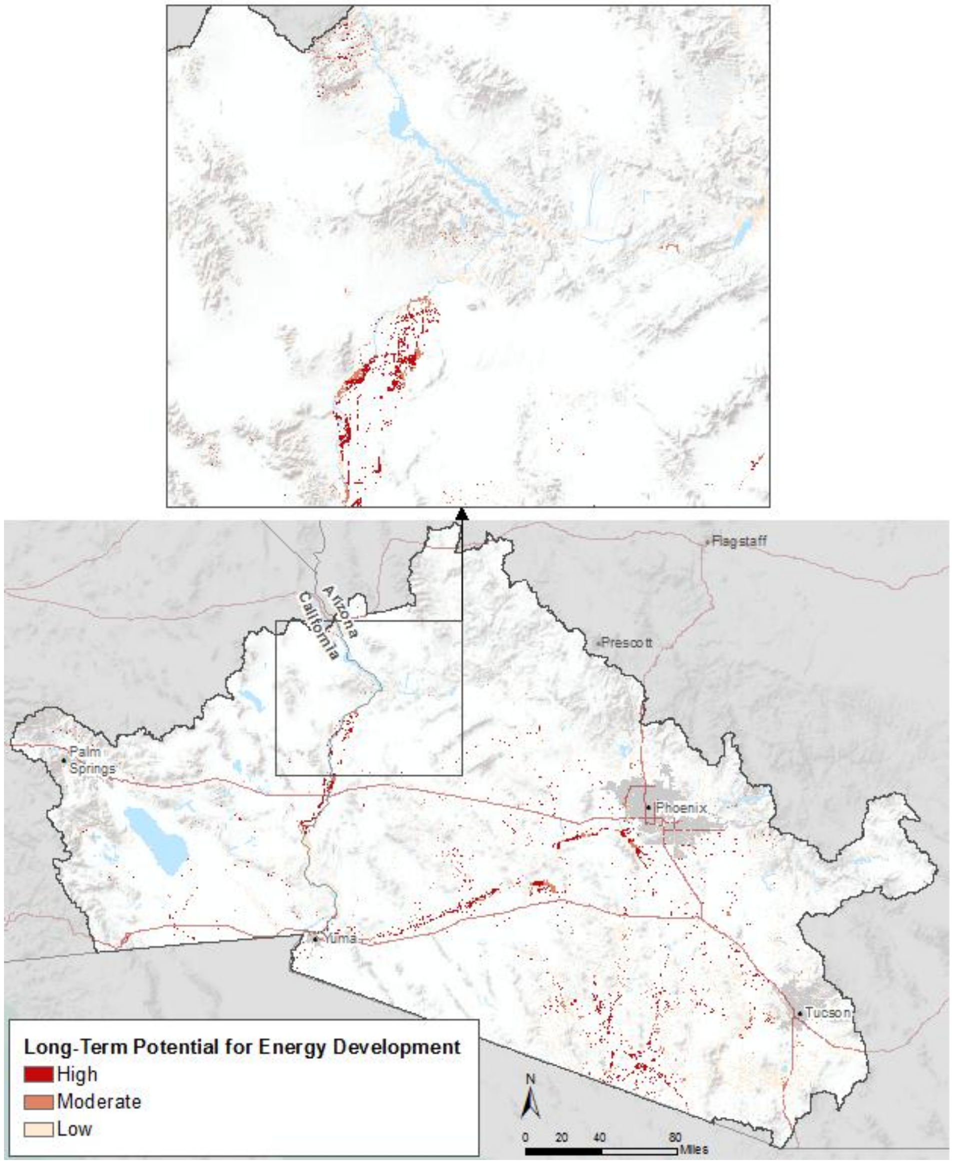


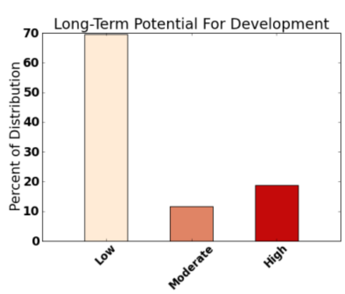


Current (solid bars) compared with near-term future (2025, hatched bars) terrestrial intactness

MQ C2. Where is Riparian Vegetation likeliest to be vulnerable to change agents in the future?

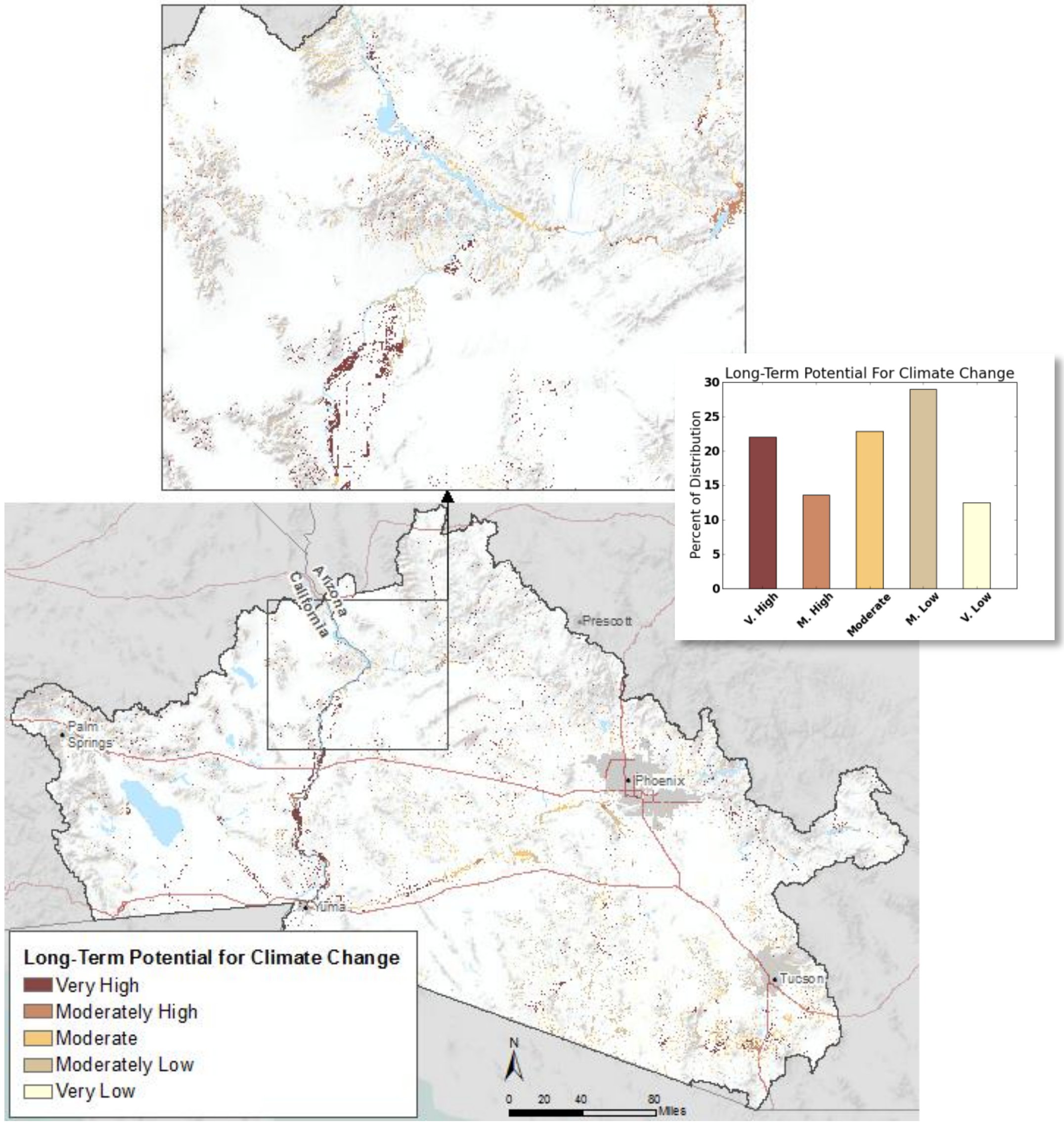
Maximum Long-Term Energy Development





MQ C2. Where is Riparian Vegetation likeliest to be vulnerable to change agents in the future?

Potential for Climate Change (2060)



Note: The management question, MQ C3. What change agents have affected Riparian Vegetation?, was not addressed because LANDFIRE BpS data (modeled vegetation reference condition) does not exist for this vegetation type.